Department of Conservation
California Abandoned Mine Lands Forum
801 K Street
Sacramento, CA 95814

February 23, 2005
Meeting Notes

Facilitator and Meeting Summary: Mary Kay Lahay, Lahay & Associates

Attendees:

1. Chris Stetler, RWQCB, Lahonton District	16. Greg Reller, Tetra Tech
2. Doug Carey RWQCB, Lahonton District	17. Debra Curry, USGS
3. Hong Kim, HK Consultants, LLC.	18. Charlie Alpers, USGS
4. Sarah Reeves, Department of Conservation	19. Roger Hothem, USGS
5. Sam Hayashi, Department of Conservation	20. James Rytuba, USGS
6. Carol Russell, Trout Unlimited	21. Stevie Duber, TAMA
7. Melanie Markin, US Fish and Wildlife	22. Julie Griffith Platter, TAMA
8. Rick Humphreys, SWRCB	23. David Lawler, BLM
9. Phil Woodward, RWQCB, Region 5	24.
10. Shayna Carney, USFS, Plumas NF	25.
11. Janine Clayton, USDA Forest Service	26.
12. Becky Wood, Teichert	27.
13. John Curless, Department of Conservation	28.
14. Rob Busby, RWQCB, Region 5	29.
15. Patrick Morris, RWQCB, Central Valley Region	30.

Agenda:

I. Welcome, Introductions and Agenda Review
II. Presentations
III. Project Announcements / Updates
IV. Next Meeting

Meeting:

I. Welcome, Introductions and Agenda Review

Sarah Reeves kicked off the meeting and welcomed AML Forum attendees. Mary Kay Lahay, the group's new facilitator, introduced herself and asked for a quick introduction (name/agency) from each of the participants as well, since many folks were first time attendees. Participants also circulated the attendance sheet and submitted business cards to Sarah to help improve the AML master list records. The agenda was reviewed and no changes were made. Lahay covered a couple ground rules on cell phones and then introduced the first presenter.

II. **An Overview of Current Site Work at Leviathan Mine by Chris Stetler, Regional Water Quality Control Board.**

Chris Stetler started by introducing his colleague, Doug Carey, who is actually the onsite manager with the day-to-day field operations technical leadership. Chris then provided us with a bit of the mine's history. Leviathan Mine is an inactive sulfur mine that the State of California acquired in 1984. It was acquired in order to cleanup and abate water quality problems caused by historic mining. Jurisdiction over the site rests with the State Water Resource Control Board, which in turn has delegated jurisdiction over pollution abatement activities to the RWQCB. The mine is located in Alpine County, California, approximately five miles east of Markleeville, California and 40 miles SE of Lake Tahoe. It's about a one-hour drive from the RWQCB office taking the "California" route. The mine is at 7000 ft. elevation, so staff taking samplings in the winter takes the "Nevada" route via Highway 395 and then snow ski or snowshoe in.

Leviathan sulfur mine operated from the 1950's to the 60's and in its heyday, 1600 tons of ore daily was taken down to Yerington to process copper ore. One of the slides presented (a view from the north) allowed Chris to point out the specific elements of the mine's location. The Leviathan Creek is pristine before going through the mine site. It crosses into tribal lands and into Nevada eventually reaching East Fork of the Carson River. This creates both bi-state and even tribal issues, so dealing with these issues is a large part of the Regional Board's work.

Anaconda, the company that conducted the open pit mining operations in the 1950's through early 1960's, reportedly sold the mine to the Alpine County Assessor's clerk for $1. Significant discharge of acid mine drainage (created when water moved through waste piles at the site) was occurring at the site. Acid mine drainage has low pH levels of 2 – 5, and contains elevated concentrations of aluminum, arsenic, copper, and other metals. Waste materials (including low grade sulfur ore and overburden materials) were eroding into the creek. After multiple enforcement orders were unsuccessful in achieving cleanup, the State purchased the mine in 1984 for $54,500. This purchase then allowed the Water Board to receive certain funds necessary to do cleanup themselves. The RWQCB began remediation work in 1984. Current RWQCB work is conducted under order from USEPA. Atlantic Richfield Corporation (ARC), successor to Anaconda, is also under USEPA order to participate in Site cleanup.

The RWQCB initiated clean up work at the Site in 1985, and constructed a pollution abatement system at a total cost of $ 4.2 million dollars. About half of this amount was obtained from ARC and in return, the Water Board signed a release of liability documents with ARC. There were four components to the 1985 clean-up project. Chris discussed all four components as summarized in some detail below:

1. **Water Evaporation Pond System:** This solution was created to capture and evaporate acid mine drainage (AMD) from underground mine workings, and to prevent the movement of water (rain and snow) through acid generating materials. AMD was discharging from Tunnel #5 at approximately 15 gallons per minute with a pH of 2.5, which was the hottest source of contamination. Twelve full acres of lined pond surface was created, with the idea that the 'bad water' would be kept in the pond and eventually evaporate. While this solution was somewhat successful, the ponds could not be sized to provide 100% containment of the influent AMD; therefore, the ponds periodically overflowed.

2. **Leviathan Creek Channel:** A concrete channel (approximately ½ mile in length was built to convey Leviathan Creek through the site to prevent further erosion of mine waste and movement of creek flows through acid generating materials. The related diagrams and information Chris shared confirmed this solution was a significant improvement.

3. **Grading:** Significant grading was done throughout the mine site in an effort to: 1) eliminate depression storage, 2) percolation of water through overburdened materials and 3) enhance run off from the site.

4. **Revegetating:** Revegetation was done in disturbed areas including the mine pit, to prevent erosion and increase evapotranspiration. Unfortunately, this strategy was not well thought out and therefore, not tremendously successful. Within two years, the grasses planted had already disappeared.

While the 1985 project was successful in reducing the pollutant load to receiving waters, it did not address all sources of pollution. There were several problems remaining after the four strategies above were implemented. First was pond overflow. There was clear evidence that pond overflow resulted in water quality impacts all the way down to the East Fork of the Carson River. In an effort to eliminate pond overflow, RWQCB worked with UC Davis on a process to treat AMD in ponds.

In 1999, the RWQCB installed a pond treatment system. Over 25 million gallons of AMD has been successfully processed through the treatment system. The method used to treat AMD held in the ponds is referred to as "bi-phasic neutralization". This process had been identified through laboratory and field-testing as a viable means to treat AMD and minimize the generation of hazardous sludge. Bi-phasic neutralization consists of neutralizing AMD with the addition of lime at two points in the treatment process. In the first phase, lime is added to raise the pH of the AMD slightly, and to precipitate iron hydroxide, and to co-precipitate arsenic. Sludge generated during the first phase of treatment is hazardous and is disposed offsite at a Class 1 waste disposal facility.

In the second phase, the pH of the AMD is raised to approximately 8 causing the remaining metals to precipitate out of solution as metal hydroxides. Sludge generated during the second phase of treatment is buried onsite. Ideally, the desired outcome is completely empty ponds, however the threat of pond overflow is never completely eliminated, especially when there is a big water year. The treatment system was operated during the 1999 through 2004 field seasons and the ponds have not overflowed since initiation of this summer treatment program in 1999. Chris shared a "before and after" location slide showing marked improvement in water quality appearance. When asked about the flow measured at this site (2 miles downstream in Leviathan Creek, Chris replied "5 CFS, maybe 10 in the spring.

In addition to the pond overflow problem, AMD discharges continuously from the channel underdrain. The channel underdrain was installed during construction of the 1985 project to lower the ground water beneath the Leviathan Creek channel. ARC has been addressing this problem with a treatment system for the past four years, but only in the summer season.

Ongoing RWQCB work includes the following:

1. **Pond water treatment:** Cost to construct the biphasic neutralization pond system was $600K. Ongoing treatment cost (now contracted out) is approximately 5 cents a gallon.
2. **Site maintenance:** While the ponds themselves have held up very well, our maintenance work has included replacement of all "boots" on both inlets and outlets of the ponds (contracted out). Work has also included road / drainage maintenance, e.g. removal of sediment, and perimeter control. Four full miles of fencing around the mine's site help prevent animals in the surrounding open grazing acreage from getting into the site. Finally, miscellaneous infrastructure repairs were also made.
3. **Site monitoring:** RWQCB has continued monthly water quality monitoring at twelve different sites. Analysis for total and dissolved metals is done on a monthly basis by the RWQCB's contract lab and all this data is incorporated into a master database managed by ARC. Chris spoke very highly of flow recorders installed and maintained by the USGS, that allow RWQCB staff to routinely and easily see flow data from their desks.

Chris shared a table of USEPA's discharge criteria to give the group a rough idea of desired water quality. He also shared charts related to the Delta Slope Stabilization Project, which will start in June of 2005. RWQCB's work will include pulling materials off the slope and adding ground water trenches. Over 100K yards of materials will need to be moved.

NOTE: More complete information can be found at RWQCB's website at:
http://www.waterboards.ca.gov/lahontan/Leviathan/LEVI_Index.htm

Questions and Answers:

Q: Are you currently tracking loads?
A: No, not yet, we'd like to. ARC has a consultant working in this area.

Q: (Rob Busby) Have you looked at ways to reduce the flow of fresh water into this area?
A: Great question! Yes we've discussed the need to do this, but funding to date has not allowed it. We are hoping the new RIFS Process will address it.

Q: Why not just plug Tunnel #5?
A: Ground around the mine tailings is too unstable, and we are convinced if we did plug it, the water would just come out somewhere else.

Q: Was the solution proposed by Water Rights group ever implemented? (by Rick H)
A: This was before my time, but I believe that difficult working relationships between our two entities resulted in no action taken, solution perceived non-viable.

II. Environmental Assessment of the Release of Mercury Mining from the New Idria Mercury District by James Rytuba, USGS.

Jim Rytuba of the U.S. Geological Survey gave this presentation which focused on the following study areas: New Idria Mercury district: New Idria, Aurora, and Alpine Mines. The U.S. Geological Survey, U.S. EPA Star Grants, and U.S. Bureau of Land Management provided funding. Jim started by acknowledging their many key research partners in the efforts including:

Chris Kim of Chapman University
Gordon Brown and Aaron Slowey of Stanford University
Sam Shawe of Oxford University
Greg Lowry of Carnegie Mellon University
Mae Gustin and Rich Zehner of University of Nevada Reno
David Lawler and Tim Moore of the US Bureau of Land Management

This mine was the second largest mercury mine in California. It's located in a very remote part of California, with very few residents. It is currently in tax default so it is likely to end up in County or State hands eventually. It has all the classic abandoned mine problems and we hope the Brownsfield grant will help us assess the potential beneficial uses of the site.

The mine opened in 1847, and Jim shared several pictorial slides showing the mine site including its mercury roasting furnaces. All ore mined was brought to a central mine facility which used pretty advanced mining methods for that time, including the electric Insley Shovel. In the war years (circa 1944), production was at its highest, additional furnaces were added totaling four, and a large amount of tailings were produced. Petroleum fired these furnaces.

Jim also shared several slides illustrating the extensive underground workings of the mine. Some open pit methods were used. A composite view of the mine illustrated a total number of mine levels of 14 over a vertical distance of more than 1,500 feet. Acid mine drainage released from haulage adit is at level 10 exiting from the site. The New Idria mine operated from 1854 through 1972, producing about 500,000 flasks of mercury. One slide showed the original flasks, which contained 76 pounds of mercury. This flask was the standard storage mechanism until the early 1980's when the unit of sale consisted of a metric ton of mercury, thereby reducing theft.

A chart of mercury deposit types was reviewed, showing two types of mercury deposits: silica carbonate and hot spring. The New Idria deposit is a silica carbonate type mercury deposit that borders on a large serpentinite body, which does not allow much vegetation. Two primary ores were found at New Idria: The first cinnabar HgS, a reddish color, and the second metacinnabar HgS, black in color, both illustrated in one of Jim's slides. Marcasite, FeS2, a main acid-generating sulfide was also found in large quantities. Jim shared a flow chart showing both the original ore dressing (done by hand) and the reduction processes, which generated lots of sulfur dioxide. Mine waste generated: low-grade ore, waste rock, calcines (tailings), condenser soot, and Hg enriched soils. Jim also shared a schematic of the cinnabar ore roasting process.

The hazards posed by mercury are many and include: (1) mine tailings, (2) acid mine drainage, (3) Hg vapor particulates (4) atmospheric release (stack loss). The later was primarily particulate Hg, locally redeposited and resulting in Hg-enriched soils around the mine site.

One study done of the calcine dumps at the New Idria Mercury Mine evaluated mercury concentration and speciation in tailings and processes that release Hg (erosion, landslides, release of Hg colloid). In collaboration with Stanford University, a new study methodology was developed. The Stanford Synchrotron Radiation Laboratory (SSRL) utilizes synchrotron-based X-ray radiation to study short-range molecular structure in materials. The high intensity of radiation allows analysis of relatively low-concentration samples ($\geq$ 100 ppm Hg), and element specificity. In addition, minimal sample preparation or treatment is required and in-situ analysis of samples is possible.

Jim also covered X-ray Absorption Spectroscopy, which observes scattering of ejected core photoelectrons from absorbing atoms to neighboring atoms The Extended X-ray Absorption Fine Structure (EXAFS) region provides local molecular-scale structural information around the absorbing element. The EXAFS region can also be used to generate a unique "fingerprint" for each distinct mercury phase Jim shared an Hg Model Compound Database developed by Dr. Chris Kim that was used to identify mercury compounds that are present in of Mine Wastes. The New Idria mine tailings that were analyzed and for which EXAFS were obtained contained 310 ppm Hg.

A study on Hg Speciation vs. Ore Roasting found that compared to the Aurora Mine, the New Idria mine samples contained much higher levels of cinnabar (81% vs. 18%), and slightly lower levels of metacinnabar (19 – 39% vs. 56%). However, the metacinnabar is much more soluble. The significance is knowing which materials are more soluble because the mercury released then can become available for methylation in reducing aquatic environments. This same study also concluded that as particle size decreases:

- Total Hg concentration increases,
- The % Hg-sulfides increases, and
- The % soluble Hg phases decrease.

These tests revealed that we have a variety of waste in tailings as follows and solubility is of great concern:

- Waste Rock (10-500 ppm): cinnabar, metacinnabar, elemental Hg
- Mine Tailings (calcines) (20-1000 ppm): cinnabar, metacinnabar, Hg oxides & sulfates
- Low Grade Ore (500-1500 ppm): cinnabar, metacinnabar, elemental Hg
- Condenser Soot (1000-12,000 ppm): metacinnabar, Hg oxides and sulfates, corderoite, elemental Hg.

Stanford University conducted Column Leach experiments with New Idria Mine Training. Hg Speciation vs. Particle Size. The study found that Hg is largely present in the crystalline phase, even in colloidal size fractions. Very large amounts of Hg sulfide are released the greater the water volume, and increase when salt is also present in the water. Other findings included:

- Mercury enriched colloids are released from mine tailings. Colloids from mercury mine tailings consist of hematite, alunite-jarosite, and amorphous Si-Al phase. Hg phases consist of HgS, and other Hg phases in tailings. Generation of colloids in mine wastes is an important release and transport mechanism

- Other field studies found that where mine drainage flows through mine tailings and seasonal changes in ionic strength occur, mercury enriched colloids are released. Transport of mercury from mine sites occurs as colloids.

Beyond the first problem of mercury release, Jim discussed an AMD pond below the New Idria Waste Dump. Studies of mercury and methylmercury concentration in mine drainage revealed that (1) both mercury species concentrations were low at the point of discharge from the mine, (2) both mercury species concentrations were higher in mine drainage that reacts with mine tailings, and (3) concentration of both mercury species in streams impacted by mine drainage was controlled by sorption onto iron oxyhydroxide and clays.

In other words, Hg is scavenged from surface mine and stream waters and sequestratered in sediments. An abundance of fine-grained Fe- and Al-hydroxides serve as effective substrates for Hg sorption. So much sorption was observed, additional experiments were conducted. One slide shown indicated that Hg is tightly bonded to iron, and sulphate layers enhance Hg sorption. Specifically:

- Hg (I • Hg (II) uptake is high on goethite and relatively constant as a function of pH.
- Uptake is high on goethite and relatively constant as a function of pH. Hg(II) uptake decreases as a function of [Cl-] due to $HgCl_2(aq)$ complexes. Low Cl- New Idria.
- Hg(II) uptake increases as a function of $[SO_4^{2-}]$ due to sulfate sorption to the substrate that reduces the positive surface charge of goethite. High sulfate at New Idria increases Hg uptake.

During storms, movement is significant and Hg could travel long distances, an obvious concern. In addition to Hg, a variety of other hazardous metals are being released. Ancient groundwater from Great Valley sequence sedimentary rocks are also contributing to the acid mine drainage problem.

Some of Jim's later slides related to studies conducted with the help of University of Nevada at Reno to assess Hg emissions. Atmospheric emissions were measured in field and in lab under constant temperature (35°C) and light and dark conditions. Mine waste samples were collected to determine Hg speciation using EXAFS analysis. Emissions results and speciation results were compared for trends. A "pie plate" method was used along with analysis of Hg levels right above ground surface. A large amount of Hg fluxed into the air, and elemental mercury was the most volatile species. One slide compared Hg emissions at New Idria Mine to the New Almaden location.

Jim ended this section by stating that mercury emissions to the atmosphere from mine wastes and enriched substrate is an important process and one not well understood currently. The following conclusions were shared as Jim concluded this portion of his presentation:

1. Hg speciation as determined by XAFS spectroscopy varies as a function type of mine waste and grain size with some mercury species more soluble and potentially more bioavailable than others. Hg concentration and % Hg-sulfides increase in calcines with decreasing particle size.

2. Laboratory column experiments indicate that colloidal transport of Hg is an important dispersal mechanism for Hg in the environment.

3. Hg colloids identified by XAFS analysis include cinnabar and metacinnabar. Other colloidal phases identified by TEM include hematite, jarosite, and a poorly crystalline aluminosilicate gel. Significantly, the amount of Hg sorbed on these types of colloids appears to be small.

4. Hg(II) is strongly sorbed by Fe(III)-hydroxides and is less strongly sorbed by Al-hydroxides. Chloride greatly reduces Hg(II) sorption in both cases, while sulfate slightly enhances Hg(II) sorption on these hydroxides.

5. Sorption processes involving Hg(II) are important in removing Hg from mine drainage as for other heavy metals such as Ni, Cr, Pb or metalloids such as As.

6. The light: dark ratio is greater among samples containing metacinnabar relative to samples containing just cinnabar (*i.e.* light enhancement of Hg emission is more pronounced in samples containing metacinnabar).

7. Flux measurements indicate non-HgS phases such as HgO (montroydite) and $Hg_6Cl_3O_2H$ (eglestonite) may be significantly larger contributors of gaseous Hg than HgS phases.

8. Substrate Hg concentration and speciation appear to be dominant factors in controlling Hg atmospheric emissions from mine wastes which is a significant source of Hg release from New Idria.

9. Understanding mercury speciation and sorption processes is critical to predicting its fate, transport, and potential bioavailability in mine-impacted regions and can assist in the design and implementation of effective remediation strategies.

NOTE: More information about the New Idria Mercury Mining District can be obtained at the USGS website: http://www.usgs.gov

The remainder of Jim's talk was a quick review of several remediations completed at the Aurora Mine site by U. S. Bureau of Land Management. Jim stated this site is on BLM land and has received lots of recreational use by off-road motor bikers. He also shared that compared to Mt. Diablo, the Rinconada location had twice the problems (tailings and flows) with a more significant impact on local bioreceptors. In answer to questions, Jim confirmed there is still asbestos mining done there, most of which is shipped to Asia, given its prohibition in the US. This project included:

(1) Assessment of Hg concentration and speciation of mine tailings (calcines and condenser soot, soils, and sediment and water in San Carlos Creek.

(2) Removal and burial of tailings and condenser soot at Scott furnace site done as part of EPA Emergency Response Clean-up in 2004 at a total cost of $150K. Jim stated he is hopeful that the Brownfields grant will fund continued assessment at the disposal site.

(3) Capping of waste repository and grading and revegetation of tailings site.

III. Project Updates / Announcements

- **Bear Creek**: Jim Rytuba announced BLM and the Water Board were working on high methylmercury detection there. They found large spring terrace measurements, carbonates replacing trees, and concentrations of 300 ppm in the sediment.
- **Rinconada Clean up project:** EPA has completed clean up of this mine site. The remediation of the mine site has mostly survived the winter storms except for some small slides on the restored slope.
- **Turkey Run site:** BLM, Region 9 EPA people and the Forest Service Bureau representatives are collaborating on cleanup plans. Priorities yet to be determined, but they are looking for a partner to help with both upstream and downstream.
- **Whiskey Town Rec Center:** Roger Hothem from USGS announced they are looking at metals due to new funding (Emergency Response) to evaluate French Fire impact.
- **Trout Unlimited:** *Russ Schnitzer* from Trout Unlimited announced they are looking to expand their business here in cold-water watersheds and to please keep them in mind. He also stated that Carol Russell of EPA was on loan to them for the next year as a lead technical specialist. Finally, Trout Unlimited has a recently published booklet available that reviews some of their projects.

IV. Next Meeting

The **next meeting date was <u>tentatively</u> set for May 18th** from 9 a.m. to noon at DOC. The final meeting date will be confirmed later.

Facilitator Lahay shared with the group that there were two agenda items she and Doug had discussed so far for the May meeting and asked the group for other potential agenda items. She, Doug and Sarah will work with the appropriate folks to finalize the agenda and get it out to the group later. The following list includes all topics that surfaced.

- Group discussion of legal liability information as it relates to presentation given earlier by Jennifer Soloway. AND/OR an 'alternate view' presentation by Rick Humphreys.
- A review of this group's primary mission, what it wants to accomplish in the next year and how to possibly change the format (has drifted over time to straight presentations) in a way that allows more collaborative group problem-solving and planning vs. continuing with solely information presentations.
- What's coming down the pike in terms of future liabilities? Possibly bring in folks from Offset project and others mentioned.
- What's OMR's plan for new revenue from the gold and silver fee. What is the future of this investment.